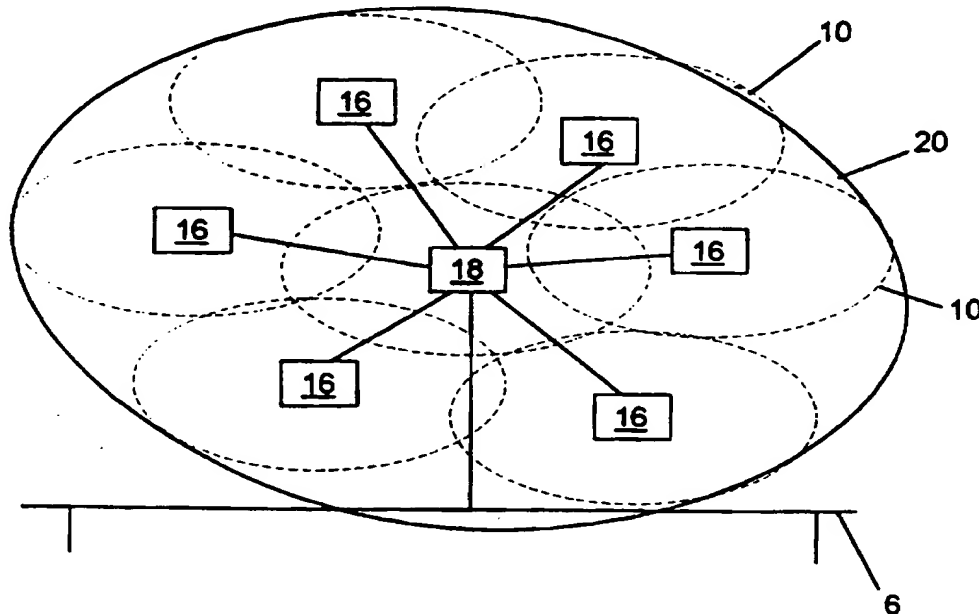




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup> :</b> <b>H04L 12/28, 12/44</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 97/38509</b> <b>(43) International Publication Date:</b> 16 October 1997 (16.10.97)
<b>(21) International Application Number:</b> PCT/GB96/02575 <b>(22) International Filing Date:</b> 21 October 1996 (21.10.96) <b>(30) Priority Data:</b> 9607507.2      11 April 1996 (11.04.96)      GB <b>(71) Applicant (for all designated States except US):</b> SYMBIONICS DEVELOPMENTS LTD. [GB/GB]; St. John's Innovation Park, Cowley Road, Cambridge CB4 4WS (GB). <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> EDNEY, Jonathan, Paul [GB/GB]; 31 High Street, Willingham, Cambs CB4 5ES (GB). BLACK, Simon, Alexander [GB/GB]; Rose Cottage, 18A Duxford Road, Whittlesford, Cambs CB2 4ND (GB). <b>(74) Agent:</b> CRAWFORD, Andrew, Birkby, A.A. Thornton & Co., Northumberland House, 303-306 High Holborn, London WC1V 7LE (GB).		<b>(81) Designated States:</b> JP, US; European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i>

**(54) Title:** WIRELESS COMMUNICATION**(57) Abstract**

A system which provides wireless communication between a computer network (6) and users of the network within a defined area comprising a plurality of base points (16) and a wireless hub (18). The base points each comprise an antenna device and define a range (10) within which a wireless communication link may be established between a user and the antenna device, and the hubs are arranged such that their ranges (20) substantially cover said defined area. The wireless hub is adapted to be connected to the computer network and to communicate with each base point. A user therefore may communicate with the computer network via one of said base points and the wireless hub.

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### Wireless Communication

5 The present invention relates to the provision of wireless communication within, for instance, a computer network such as a local area network (LAN).

10 Networks are well known and in a basic form provide wired links between computers and other devices to enable communication between the different computers and their users and also to enable use by the various devices of shared resources such as printers or data storage facilities. It is also known more recently to provide some of the links in such networks by way of wireless communication. In particular the link from a portable computer into the network may be made by a wireless link. This is advantageous from the point of view of portability of the computer and ease of connection for a user.

15 In a conventional network of the above mentioned type user stations communicate wirelessly with an Access Point. The Access Point is, in simple terms, an antenna device having associated circuitry to provide the interface between the wireless communication with the user station and the network as a whole. The antenna device may be a single antenna element or an array of such elements.

20 Clearly in such a system the ability of a user to connect to the network using the Access Point is limited by the range of the antenna device of the Access Point. The wireless communication system has a limited range and communication with the Access Point is only possible within that range. Thus each Access Point has a roughly circular area inside which communication is possible. It is however common that such a circular operating area may not correspond to the shape of the building or premises to be covered by this system.

25 One standard to be defined for wireless - LANs is IEEE802.11 and this operates broadly as just mentioned. that is with an Access Point covering a

relatively large area. Such an Access Point is relatively high power and, because of the large area covered, is limited in its speed of operation. In particular, IEEE802.11 Access Points can function at 1 or 2 Mbps (Mega bits per second).

The present invention provides a system for providing wireless communication between a computer network and user devices of the network within a defined area comprising:

a plurality of first communication devices each comprising an antenna device and defining a range within which a wireless communication link may be established between a user device and the antenna device, the plurality of first communications devices being arranged such that their ranges substantially cover said defined area; and

a second communication device adapted to be connected to the computer network and in communication with each of said first communication devices;

whereby a user device may communicate with the computer network via one of said first communication devices and said second communication device.

The present invention thus provides, in the terms of the preferred embodiment comprising a wireless hub which is connected to the main network and a plurality of base points. The functions of the Access Point are divided between the wireless hub and the base points, in particular each base point is provided with an antenna device for communication with user stations and preferably the wireless hub is provided with the hardware and software necessary to communicate with the main network.

The function of the Wireless Hub and the Base Points are quite distinct and in the preferred arrangement the Base Points are of low complexity and depend on the Wireless Hub for operation.

The provision of a plurality of first communication devices or base points enables the coverage area of the Distributed Access Point to be tailored to

the needs of the particular installation and potentially there is greater band width provided for users to access the network.

According to a preferred embodiment of this invention the ranges of the antenna devices of the base points are sufficiently small such that they do not  
5 have to comply with the IEEE802.11 standard enabling the system to be freely configured. In particular, the smaller power and range of each antenna permits operation of each antenna at speeds of the order of 10 Mbps, that is up to an order of magnitude faster than conventional IEEE802.11 Access Points. This, in connection with the provision of a plurality of antenna devices in each Distributed  
10 Access Point and a plurality of radio channels at the antenna device of each base point, provides a considerable increase in the communication bandwidth available at each Access Point.

In a further preferred embodiment a central unit provides an additional wireless cell covering broadly the same area as the Distributed Access  
15 Point of this invention. This enables communication with the network by a user either by the additional cell or by the cells of the Distributed Access Point. This means that a user can select whichever means of communication is better at the time. In the preferred embodiment the additional cell operates according to a known standard, eg IEEE 802.11. This ensures compatibility with a standard  
20 system such that visiting users can access the network using standard, eg IEEE802.11, communications.

In further preferred embodiments the invention provides centralised frequency channel assignment between the antenna devices of the various base points, position location of people and equipment using the distributed nature of  
25 the invention and also potential increases in the reliability of the overall network.

The present invention will be better understood from the following description of preferred embodiments in conjunction with the accompanying drawings, in which:

Fig. 1 illustrates, in schematic form, an Access Point in a

conventional wireless network;

Fig. 2 illustrates, in schematic form, a Distributed Access Point according to a preferred embodiment of the invention;

Fig. 3 illustrates the functions of a typical Access Point,

5 Fig. 4 illustrates, in schematic form, a second preferred embodiment of the invention;

Fig. 5 illustrates a schematic representation of a user device for use with the embodiment of Fig.4; and

10 Fig. 6 and 7 illustrate a further advantageous feature of the invention.

In broad terms and as will be discussed in more detail below, the preferred embodiment of the invention is a system which provides wireless communication between a computer network and users of the network within a defined area which comprises a plurality of base points and a wireless hub. The base points each comprise an antenna device and define a range within which a wireless communication link may be established between a user and the antenna device, and the hubs are arranged such that their ranges substantially cover said defined area. The wireless hub is adapted to be connected to the computer network and to communicate with each base point. A user therefore may communicate with the computer network via one of said base points and the wireless hub.

20 In a conventional wireless network as shown, for example, in Fig. 1, user stations 2, for instance those designated A, B, communicate with an Access Point 4. The Access Point 4 receives data from the user stations 2 and reformats the data before transmitting it onto the wired network 6 in the appropriate format. Similarly the Access Point 4 receives data from the wired network 6, reformats it and transmits it to the user stations 2 using the wireless medium such as radio waves or modulated light.

The basic arrangement according to an embodiment of the invention is shown in Fig. 2. In this arrangement the functions of an Access point are

divided and some of the functions are distributed across multiple devices. The collective system is then known as a "Distributed Access Point" 14 which comprises a Wireless Hub 18 and a plurality of Base Points 16.

5 The Wireless Hub 18 is attached to the network and the Base Points 16 communicate through the wireless medium with the user stations 2.

Figure 3 illustrates the various functions carried out by a typical Access Point of Fig. 1. Of those shown in Figure 3, the layers of "Network Interface", "Network Protocol", "Message Queuing", "Message Management", "Wireless Management", "Wireless Protocol" and are handled by the Wireless Hub 18 in Fig. 2 while the function of the "Wireless Transmitter / Receiver" & "Wireless Antenna" are handled in the Base Points 16. In a typical implementation, the Wireless Hub 18 is a device incorporating network interface hardware and a microprocessor. The microprocessor performs all necessary protocol operations and passes a simplified data stream to each Base Point 16 as appropriate. In this case the Base Point 16 could simply comprise a radio and antenna unit.

As an alternative implementation the "Wireless Protocol" layer could be implemented in the Base Point 16. In this case the Wireless Hub 18 would handle all messages from the network and determine the correct time and method to transmit over the wireless medium. However, the actual task of formatting the data and sending over the wireless link would be performed by the Base Point 16. In this case the Base Point 16 might comprise a simple micro-controller and a radio unit.

25 The benefit of implementation as a Distributed Access Point is that the Base Point units can be relatively low complexity and cost and can be placed in convenient physical locations in a building or premises. By this means it is possible to effectively extend the range of the simple access point by using multiple Base Points and to adjust the shape of the covered area by correct positioning of the Base Points.

Fig. 4 illustrates the coverage of an area by the communication regions 10 of a number of Base Points 16 associated with a Wireless Hub 18. In this arrangement, the central Base Point 16 is formed in the same unit with the Wireless Hub 18.

5 Fig. 4 also illustrates the basic arrangement of the second embodiment of the invention. The characteristics of the indoor radio channel are such that there is a trade-off between range and data rate. It is possible to offer high speed data communications at short range, or lower speed communications at longer range.

10 A combination of these is shown in the embodiment of Fig. 4 with short range high speed cells 10 being provided by the Base Points 16 of the first embodiment and a longer range lower speed cell 20 being additionally provided, in the illustrated case by the Wireless Hub. In the preferred case, cell 20 is provided according to the IEEE802.11 standard or some similar standard.

15 In this embodiment a wireless or user station 2 wishing to communicate with the network can communicate in one of two modes using a single radio unit: high speed short range, or low speed long range. The wireless station 2 may have a dual mode radio and logic to automatically detect and select the best possible service at any given location without user intervention.  
20 Alternatively it may be designed to work according to one of the two modes.

Fig. 5 is a block diagram of a typical implementation of a wireless station 2 which may be used in a system architecture such as illustrated in Fig.4 which provides cells having two distinct characteristics. The wireless station 2 comprises a computing device 50 which is the core of the device which desires to  
25 communicate. This is connected to an antenna 52, by way of which wireless communications are established, via radio interface means 54.

Radio interface means 54 comprises a dual-mode radio 542 capable of establishing communication using either cells 10 or cell 20 of Fig.4. The received signal from radio 542 is input to signal detection & quality assessment



means 544. On the basis of the output from means 544, wireless management means 546 controls the radio 542 to detect the available communication options and operate according to the optimum mode at the present time and location. Wireless protocol means 548 provides the necessary interface between the computing device 50 and the radio 542 according to the selected mode of operation.

As mentioned above each communication cell is provided by a radio transceiver of the appropriate type and cells may overlap. The radio transceivers are connected to control units that provide control and routing of data packets. There are two types of radio transceiver one capable of high speed short range operation and the other capable of lower speed but longer range operation. The dual mode wireless station is able to detect the available communication options at any location and automatically select the optimum. This offers the combination of performance in areas of high user density with cost effective radio coverage throughout a building.

A further preferred feature of this invention is a method of operating the Base Points at various communication frequencies. Spread spectrum, using either frequency hopping or direct sequence, is a radio mechanism used in wireless data communication. In a conventional wireless network user stations communicate with an Access Point. The Access Point selects a pseudo-random sequence of frequencies and slowly hops between the frequencies within the pattern. Alternatively the Access Point can choose a pseudo-random sequence of bits to use for the modulation signal. Wireless stations that are registered with the access point select the same pseudo random sequence and synchronise with the hop timing. In this way the wireless station and access point are able to communicate.

Radio coverage within a building for wireless LAN is typically provided by a number of access points. The radio coverage cells of the access points may overlap. Frequency hop patterns or modulation sequence patterns are

randomly selected for each radio cell on initialisation. In this way interference is minimised, but not eliminated. If collisions occur between neighbouring cells, data must be re-transmitted, causing a reduction in the efficiency of the system.

In this invention this interference problem is overcome by having a centralised control algorithm to assign the channel frequency for each cell. The channel uses are coordinated such that interference between cells is avoided. This also allows frequency reuse to be maximised. In an actual implementation this centralised control algorithm resides within a wireless hub. Each radio cell is provided by a transceiver connected to the wireless hub by conventional LAN cabling. A protocol exists between the wireless hub and the transceiver that enables channel assignment to be controlled and reallocated dynamically.

Wireless LAN systems as described above are installed within buildings to provide wireless data communication between computing devices. A typical installation may consist of a number of fixed access points that provide a mechanism for wireless stations to access a wired network. Each access point provides radio coverage over a small area - typically between 50 and 300 ft. The access points are connected and are arranged to provide coverage over an entire building. This provides the facility for a further preferred feature of this invention.

According to this feature tags are provided which can communicate with the wireless LAN to perform location detection. There are two possible applications

- i) Computing equipment may be 'asset tagged' and its position within a building located.
- ii) Personnel may carry a tag which communicates with the wireless LAN to provide a location.

Finally, the arrangement of this invention allows dynamic reconfiguration of a wireless LAN installation between wireless and wired links to maintain network integrity.

A wireless LAN installation along the lines of Fig. 2 is pictured in

Fig. 6 which includes two Distributed Access Points 14. In normal operating mode the wireless stations 2 A, B communicate via the base points 16, wireless hubs 18 and the wired network 6. A fault in the wireless hub 18, or wired network 6 will cause the communication path between A and B to be broken.

5                   However, according a preferred feature of the invention illustrated in Fig.7 there is additional functionality within the wireless hubs 18 such that they are able to detect the failure of a communications path and re-establish a path via a wireless link. This is shown in figure 7 where a failure or fault 70 on the wired network 6 between the wireless hubs 18 results in a wireless link being established  
10                   between two base points 16. Traffic can still flow between the users A and B through forwarding within the base points 16.

Claims:

1. A system for providing wireless communication between a computer network and user devices of the network within a defined area comprising:
- 5 a plurality of first communication devices each comprising an antenna device and defining a range within which a wireless communication link may be established between a user device and the antenna device, the plurality of first communications devices being arranged such that their ranges substantially cover said defined area; and
- 10 a second communication device adapted to be connected to the computer network and in communication with each of said first communication devices;
- whereby a user device may communicate with the computer network via one of said first communication devices and said second communication device.
- 15
2. A system according to claim 1 in which the second communication device comprises control means arranged to control the operation of the plurality of first communication devices.
- 20
3. A system according to claim 2 in which said control means is arranged to co-ordinate the use of a number of different radio frequencies by the plurality of first communication devices to establish their communication links.
- 25 4. A system according to claim 1, 2 or 3 in which the second communication device comprises means arranged to process communications received from said first communication devices such that they are suitable for transmission to the computer network.

5. A system according to any preceding claim further comprising a third communication device comprising antenna means defining a range within which a wireless communication link may be established between a user device and the antenna device of the third communication device and being adapted to be  
5 connected to the computer network, the third communication device being arranged such that its range covers at least a significant proportion of said defined area,

whereby a user device may communicate with the computer network via said third communication device.

10

6. A system according to claim 5 in which the third communication device is adapted to be connected directly to the computer network.

7. A system according to claim 5 in which the third communication  
15 device is adapted to be connected to the computer network via the second communication device.

8. A system according to claim 5, 6 or 7 in which communications established via the third communication device are according to a different  
20 standard from those established via the first and second communication devices.

9. A system according to claim 8 in which communications established via the third communication device are slower than those established via the first and second communication devices.

25

10. A system according to any preceding claim comprising two of said second communication devices, each having an associated plurality of said first communication devices arranged to cover two of said defined areas, which areas overlap,

12

the system further comprising means to detect the occurrence of a fault in the computer network connecting the two second communication devices and means to establish an alternative communication path via said two second communication devices and two associated first communication devices.

5

11. A user device for use in the system of any of claims 5 to 9 comprising means arranged to establish a wireless communication link with one of said first communication devices and means arranged to establish a wireless communication link with said third communication device.

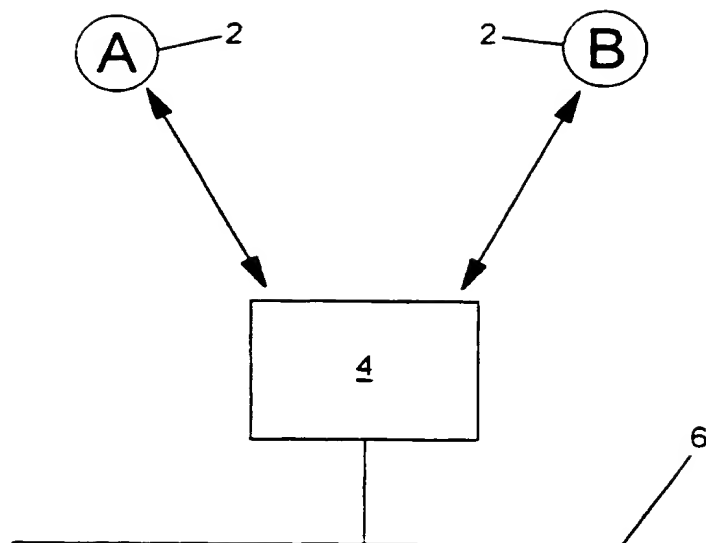
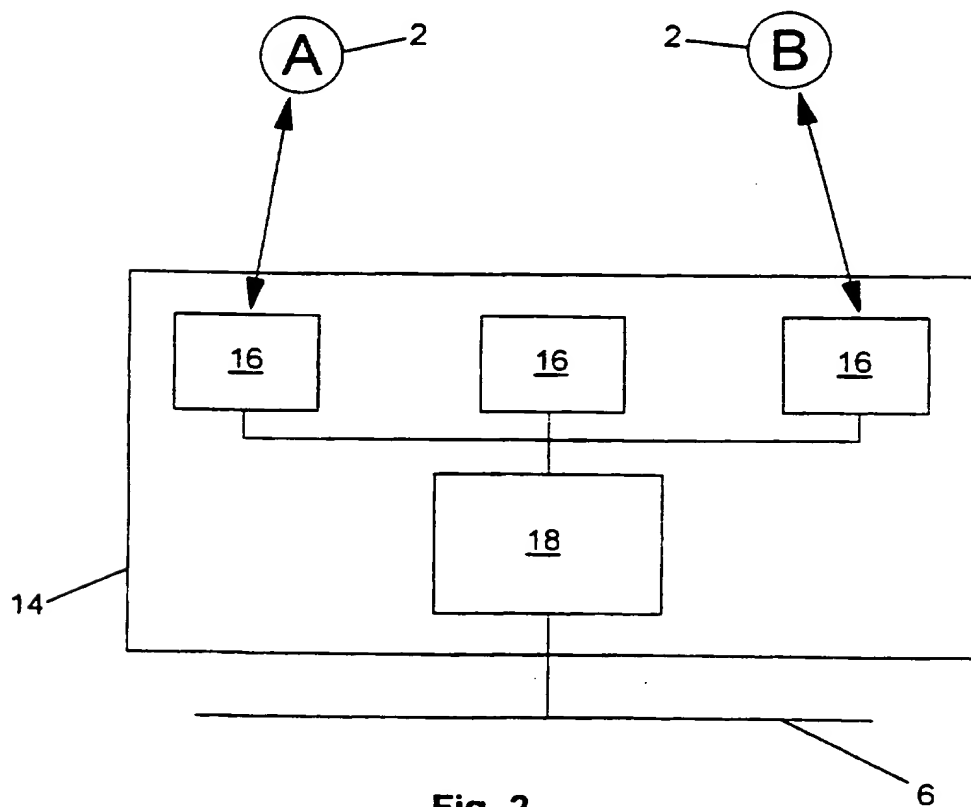
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means adapted to assess the availability and/or quality of communication with the first and third communication devices, and

control means adapted to cause the device to communicate with either one of said first communication devices or the third communication device according to said assessment.

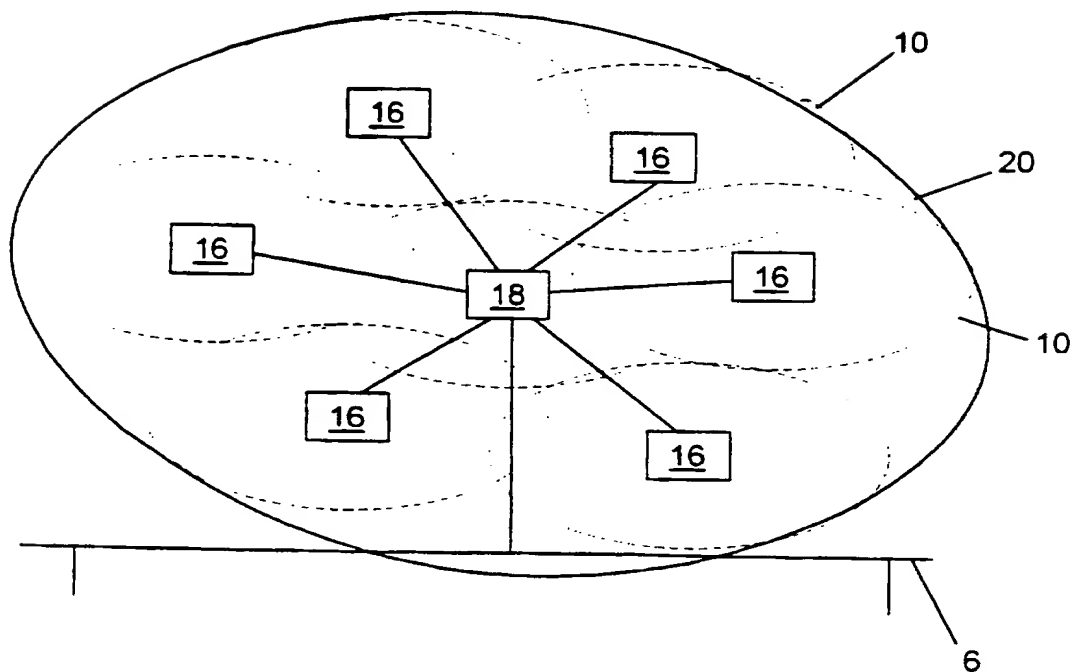
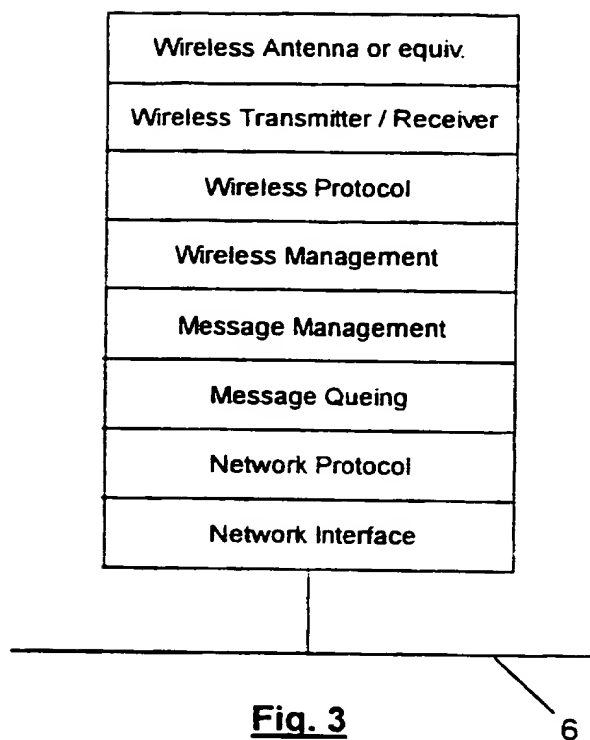
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Fig. 1Fig. 2

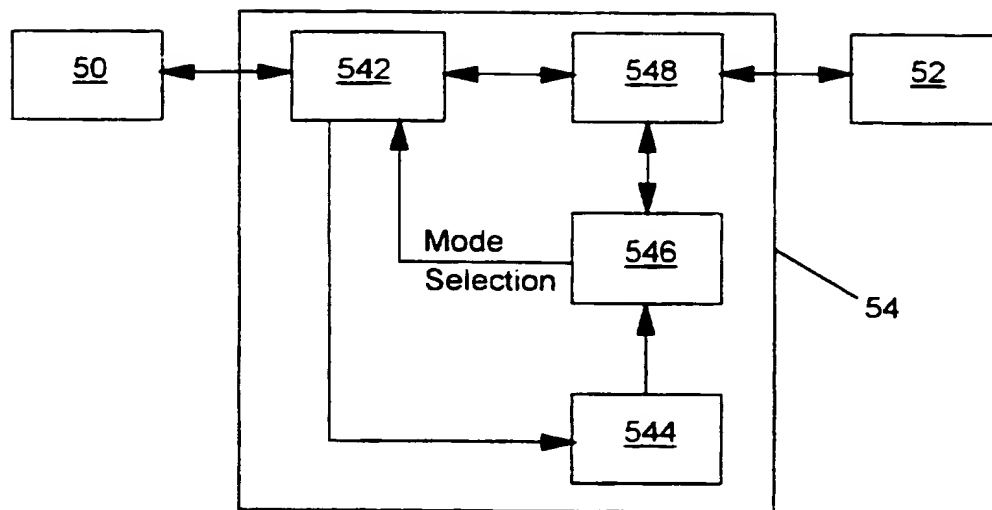
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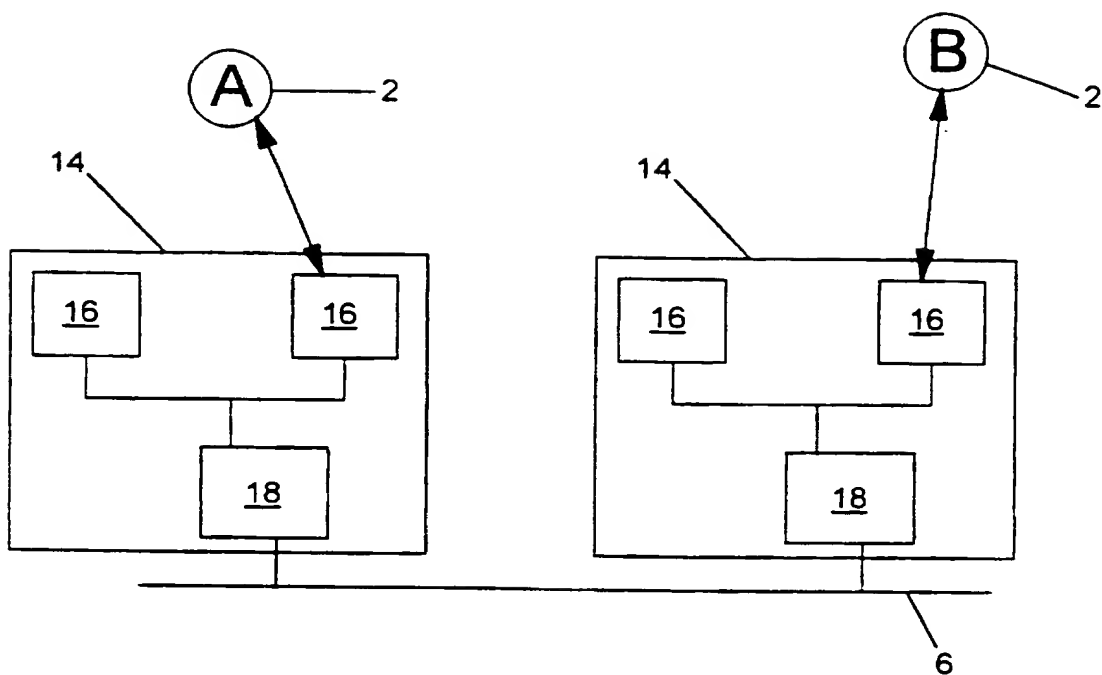
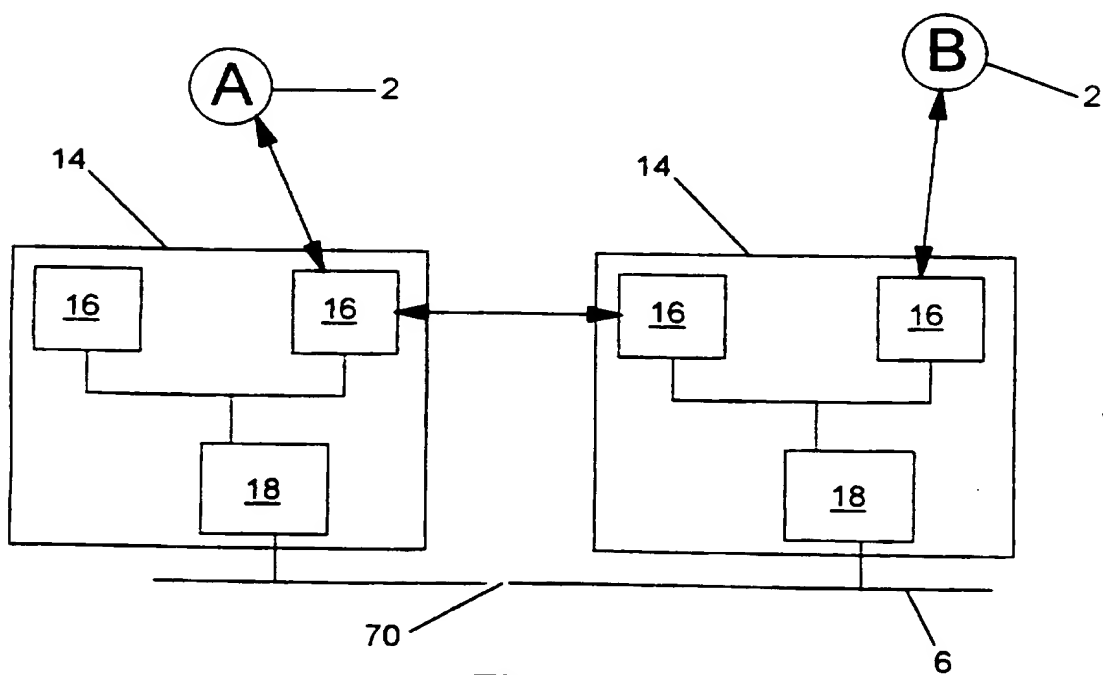


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**3/4****Fig. 5**

4/4

**Fig. 6****Fig. 7**

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# INTERNATIONAL SEARCH REPORT

Int. Application No  
PC 1/GB 96/02575

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 H04L12/28 H04L12/44

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	EP,A,0 504 122 (TELEFONAKTIEBOLAGET L M ERICSSON) 16 September 1992 see column 1, line 3 - line 6 see column 2, line 48 - column 3, line 28 see column 4, line 14 - line 58 see column 7, line 23 - line 38 see column 10, line 25 - column 11, line 6 see column 12, line 34 - line 49 see column 14, line 13 - line 44 see figures 1,7,8	1,2,4,5, 7,11
A		3,6,8-10

☒ Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search

23 January 1997

Date of mailing of the international search report

03.02.97

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# INTERNATIONAL SEARCH REPORT

Inter:      nal Application No  
PC1/GB 96/02575

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	WO,A,95 17724 (NORAND CORPORATION) 29 June 1995 see page 1, line 9 - page 3, line 20 see page 8, line 18 - page 9, line 21 see figure 3	6,10
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A	EP,A,0 621 707 (INTERNATIONAL BUSINESS MACHINES CORPORATION) 26 October 1994 see page 2, column 3 - column 6 see page 3, line 41 - line 56 see page 4, line 40 - page 5, line 8 see page 7, line 50 - page 8, line 55 see figures 1A,5 -----	1-11

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International Application No

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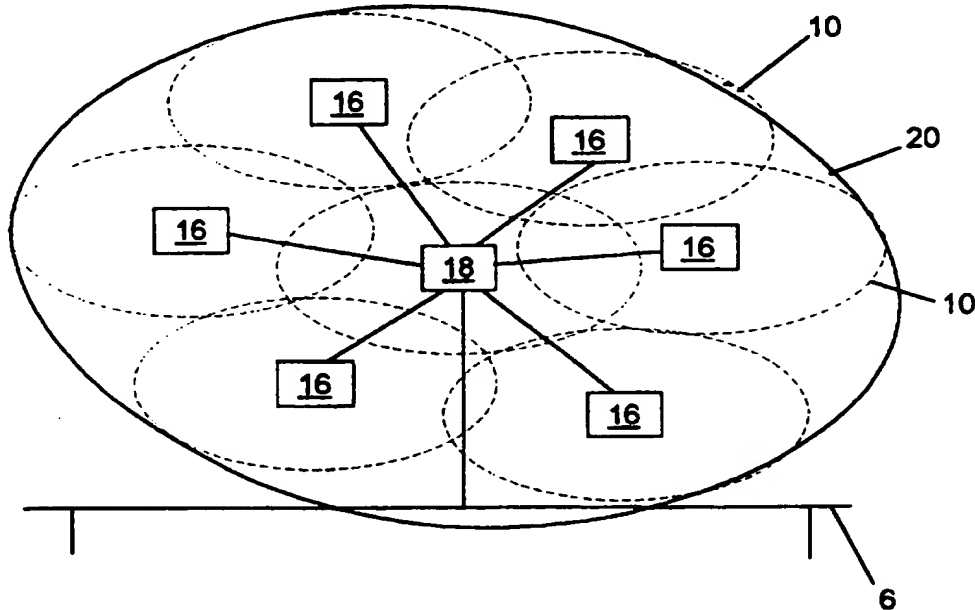
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification <sup>6</sup> : <b>H04L 12/28, 12/44</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 97/38509</b> (43) International Publication Date: 16 October 1997 (16.10.97)</p>
<p>(21) International Application Number: <b>PCT/GB96/02575</b> (22) International Filing Date: 21 October 1996 (21.10.96) (30) Priority Data: 9607507.2 11 April 1996 (11.04.96) GB (71) Applicant (for all designated States except US): SYMBIONICS DEVELOPMENTS LTD. [GB/GB]; St. John's Innovation Park, Cowley Road, Cambridge CB4 4WS (GB). (72) Inventors; and (75) Inventors/Applicants (for US only): EDNEY, Jonathan, Paul [GB/GB]; 31 High Street, Willingham, Cambs CB4 5ES (GB). BLACK, Simon, Alexander [GB/GB]; Rose Cottage, 18A Duxford Road, Whittlesford, Cambs CB2 4ND (GB). (74) Agent: CRAWFORD, Andrew, Birkby; A.A. Thornton &amp; Co., Northumberland House, 303-306 High Holborn, London WC1V 7LE (GB).</p>		<p>(81) Designated States: JP, KR, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> With international search report.</p>

(54) Title: WIRELESS COMMUNICATION



(57) Abstract

A system which provides wireless communication between a computer network (6) and users of the network within a defined area comprising a plurality of base points (16) and a wireless hub (18). The base points each comprise an antenna device and define a range (10) within which a wireless communication link may be established between a user and the antenna device, and the hubs are arranged such that their ranges (20) substantially cover said defined area. The wireless hub is adapted to be connected to the computer network and to communicate with each base point. A user therefore may communicate with the computer network via one of said base points and the wireless hub.

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